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UNITED STATES
DEPARTMENT OF AGRICULTURE
DEPARTMENT CIRCULAR 257
Washington, D. C. February, 1923

COMPOSITION OF FILTER PRESS (LIME) CAKE

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THE DRY MATERIAL of the filter press (lime) cake produced in the process of manufacture of beet sugar consists largely of calcium carbonate, and there appears no reason to believe that this carbonate of lime does not possess a value equal to that of other carbonate of lime ordinarily applied to soils. The value of this press cake for the purpose of liming soils has been indicated by the conclusions of A. W. Skudrna,[1] H. Claassen,[2] J. A. Brock,[3] and other investigators.

TABLE 1.—*Composition of filter press (lime) cake as stated in the literature.*

References consulted.	Range of values for water-free material (per cent).					
	$CaCO_3$.	P_2O_5.	K_2O.	Nitrogen.	$Fe_2O_3+Al_2O_3$.	Organic material.
American	[1] 59.6 to 112	Trace to 2.8	0.13 to 0.20	0.15 to ——[2]	6.9 to 7.3	15.6 to 19.4
Foreign	55.0 to 84.1	0.9 to 3.3	.05 to .30	.14 to 0.44	.5 to 4.2	5.0 to 16.00

[1] The figures for CaO and water given in one reference afford, by calculation, 112 per cent $CaCO_3$ on a water-free basis.
[2] Maximum not given.

Numerous references may be found in which the composition of the material is given, but the greater number of them give merely average or maximum and minimum figures. In connection with the investigations of the Office of Sugar-Plant Investigations of the Bureau of Plant Industry it was desired to ascertain the composition

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[1] Skudrna, A. W. Steffens house waste water has great agricultural value. *In* Sugar, v. 20, p. 220–221, illus. 1918.

[2] Claassen, H. Beet-sugar manufacture, p. 257, New York. 1906.
——— Die Trocknung des Pressschlammes. (Abstract.) *In* Centbl. Zuckerindus., Jahrg. 18, p. 864–865. 1910.

[3] Brock, J. A. Facts about lime. *In* Facts about Sugar, v. 10, p. 31. 1920.

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of this material, and in view of the limited number of American references it was found advisable to examine representative samples with reference to their content of calcium, phosphoric acid, potash, and nitrogen.

TABLE 2.—*Composition of filter press (lime) cake.*

Description of samples, number, and source.	Collected (fall of year).	Analytical values for water-free material (per cent).											
		Material insoluble in strong HCL.			Soluble silica.	$Al_2O_3+Fe_2O_3$.	K_2O.	P_2O_5.	NH_3.	CaO.	$CaCO_3$.[1]	Undetermined.[2]	Total organic material (approx.).[3]
		Total.	Organic.	Inorganic.									
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Fresh cake:													
No. 1, Utah	1918	3.04	1.48	1.56	0.73	1.90	0.21	0.52	0.30	45.72	81.58	11.72	13.20
No. 2, Utah	1918	5.81	1.60	4.21	.88	1.49	.25	.66	.28	45.86	81.83	8.80	10.40
No. 3, Utah	1919	1.95	1.32	.63	.64	.72	.09	.46	.28	46.52	83.01	12.85	14.17
No. 4, Utah	1919	1.87	1.30	.57	.66	.43	.14	.37	.28	46.75	83.42	12.83	14.13
Average	......	3.17	1.43	1.74	.73	1.14	.17	.50	.29	46.21	82.46	11.55	12.98
No. 5, Colorado	1918	5.07	1.45	3.62	.43	1.75	.17	.50	.34	45.64	81.43	10.31	11.76
No. 6, Colorado	1918	3.69	.96	2.73	.64	.94	.17	.36	.28	48.57	86.66	7.26	8.22
No. 7, Colorado	1918	3.22	1.09	2.13	.47	.80	.14	.35	.27	48.79	87.06	7.69	8.78
No. 8, Colorado	1918	6.20	1.26	4.94	.37	.65	.20	.32	.22	47.69	85.09	6.95	8.21
No. 9, Colorado	1919	2.73	1.51	1.22	1.42	1.38	.11	.32	.28	45.31	80.85	12.91	14.42
Average	......	4.18	1.25	2.93	.67	1.10	.16	.37	.28	47.20	84.22	9.02	10.28
No. 10, Kansas	1919	2.88	1.65	1.23	.82	1.41	.12	.88	.38	45.68	81.51	12.00	13.65
No. 11, Michigan	1918	3.27	1.54	1.73	.79	1.61	.38	.62	.40	48.16	85.93	7.00	8.54
No. 12, Michigan	1918	4.05	1.80	2.25	1.03	1.72	.24	.55	.42	47.41	84.59	7.40	9.20
No. 13, Michigan	1919	3.34	1.92	1.42	.68	.68	.13	.66	.37	47.68	85.08	9.06	10.98
No. 14, Michigan	1919	3.50	1.80	1.70	.70	.72	.14	.66	.37	47.50	84.75	9.16	10.96
Average	......	3.54	1.77	1.78	.80	1.18	.22	.62	.39	47.69	85.09	8.16	9.92
Average (14 samples)	......	3.62	1.48	2.14	.73	1.16	.18	.52	.32	46.95	83.77	9.71	11.19
Highest	......	6.20	1.92	4.94	1.42	1.90	.38	.88	.42	48.79	87.06	12.91	14.42
Lowest	......	1.87	.96	.57	.37	.43	.09	.32	.22	45.31	80.85	6.95	8.21
Weathered cake:													
No. 15,[4] Colorado	1918	4.91	.82	4.09	.25	.80	.50	.39	.31	50.08	89.36	3.48	4.30
No. 16,[5] Colorado	1918	14.33	1.10	13.23	.41	1.15	.55	.37	.27	45.01	80.31	2.61	3.71
No. 17,[6] Colorado	1919	19.16	3.09	16.07	.69	1.60	.16	.43	.31	41.44	73.94	3.71	6.80
No. 18,[7] Colorado	1919	16.35	1.94	14.41	.47	1.32	.14	.38	.20	42.55	75.92	5.22	7.16
No. 19,[4] Kansas	1919	7.44	.99	6.45	.44	.95	.08	.97	.15	48.02	85.68	4.29	5.28
No. 20,[7] Kansas	1919	9.65	.83	8.82	.44	.89	.19	.77	.14	44.55	79.49	8.43	9.26
No. 21,[4] Kansas	1919	9.68	.80	8.88	.43	1.05	.13	.73	.14	46.45	82.88	4.96	5.76
No. 22,[7] Kansas	1919	4.28	.64	3.64	.35	.95	.13	.75	.20	44.98	80.26	13.08	13.72
Average (8 samples)	......	10.73	1.28	9.45	.44	1.09	.24	.60	.22	45.39	80.98	5.72	7.00
Highest	......	19.16	3.09	16.07	.47	1.60	.55	.97	.31	50.08	89.36	13.08	13.72
Lowest	......	4.28	.64	3.64	.25	.80	.08	.37	.14	41.44	73.94	2.61	3.71
Average (22 samples)	......	6.20	1.40	4.80	.62	1.13	.20	.55	.28	46.38	82.76	8.26	9.66

[1] The figures for $CaCO_3$ are calculated from CaO.

[2] The figures for "Undetermined" are 100 minus the sum of columns 3, 6, 7, 8, 9, 10, and 12.

[3] The figures for "Total organic material (approx.)" are the sum of columns 4 and 13. This affords an approximation only, as no account is taken of small quantities of magnesium compounds, etc., but the results are considered sufficiently close for the purposes of these analyses.

[4] Surface of pile.

[5] One foot below surface.

[6] Surface of old settling basin.

[7] Two feet below surface.

Table 1 gives the range of values found in the references consulted, while Table 2 gives the results of the analyses made by the writer.

The samples were broken into small pieces, thoroughly air dried at about 26° C., and ground. At the time of making the analyses the water in the ground material was determined by drying at 100° C., and the results were calculated to a water-free basis. The methods used were those given in "Methods of Analysis," Association of Official Agricultural Chemists, 1920. The samples of fresh cake were collected direct from the filter presses, and the samples of weathered material from masses that had been in situ for about one year.

The figures for potash, phosphoric acid, ammonia, and calcium upon a water-free basis show no marked differences between the composition of the fresh and the weathered cake. The material as applied to the soil would contain anywhere from 50 to 20 per cent of water, depending upon whether it was used direct from the filter presses or after having become dried through exposure to the atmosphere. Its composition in pounds per ton of 2,000 pounds upon a basis of 50 per cent water and 20 per cent water, as calculated from the analyses, is given in Table 3. These figures indicate that 1 ton of average material containing 20 per cent water would afford approximately 4½ pounds of NH_3, 8½ pounds of P_2O_5, 3 pounds of K_2O, 740 pounds of CaO (or 1,325 pounds of $CaCO_3$), and 150 pounds of organic material. Thus, the carbonate of lime in 1½ tons of average filter press cake containing 20 per cent water would be equivalent to the carbonate of lime in 1 ton of high-grade ground limestone. Examination of the material indicates that the P_2O_5 is present in a form different from that of the "available" P_2O_5 in ordinary fertilizer, and it is not to be concluded that it is equivalent in availability.

The dry material of filter press (lime) cake consists largely of carbonate of lime, and the cake undoubtedly affords a satisfactory material for liming soils. It also contains comparatively small quantities of nitrogen, phosphoric acid, potash, and organic material. These fertilizer materials, while adding to the total quantity of such constituents in the soil to which it may be applied, do not necessarily afford immediately available plant food.

TABLE 3.—*Composition of filter press (lime) cake expressed in pounds per ton.*

Constituents.	Basis of 50 per cent water in cake.			Basis of 20 per cent water in cake.		
	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.
K_2O	2.0	5.5	0.8	3.2	8.8	1.3
P_2O_5	5.5	9.7	3.2	8.8	15.5	5.1
NH_3	2.8	4.2	1.4	4.5	6.7	2.2
CaO	463.8	500.8	414.4	742.1	801.3	663.0
$CaCO_3$	827.6	893.6	739.4	1,324.2	1,429.8	1,183.0
Organic material (approximate)	96.6	144.2	37.1	154.6	230.7	59.4

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